Postharvest Research Program
San Luis Valley Research Center
Proposals for 2007

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The Postharvest research program at San Luis Valley Research Center is designed to address some of the issues faced by the industry related to storage management and physiological disorders during storage. The research program caters to the unique needs of the industry in the valley. This includes developing storage regimes for the newly released cultivars from SLVRC breeding program. These projects are carried out in collaboration with other faculty at SLVRC and also at main campus. Detailed project descriptions are given below, describing methods and expected outcomes.

Project 1

Title: Sprout suppression in stored seed potatoes, especially the use of DMN

Nature, scope, objectives of proposed research

A relatively new sprout inhibitor, ethyl substituted naphthalenes are naturally occurring in potato tubers, and contributes to flavor in baked potatoes (Buttery et al 1970 and Coleman et al 1981). These compounds showed sprout suppressant activity on a short-term basis of approximately 30 days. Mode of action of these compounds for sprout suppression is by regulating phyto-hormones (Meigh et al 1973, Kleinkopf et al 2003). The short-term nature of sprout suppressant activity of 1, 4-DMN allow for potential use in the seed industry. 1, 4-DMN is marketed specifically to control sprouting in seed during storage and transit.

The main objective of this study is to find how different cultivars respond to 1, 4-DMN application in seed storage.

Methods and facilities, including any resource needs at the SLVRC

Cultivars with different levels of dormancy will be tested at different concentration of 1, 4-DMN applied at various intervals. Tubers will be stored at 45°F to stimulate commercial seed storage conditions. Tubers after five months of storage will be regularly evaluated for sprouting. Seed will be planted and tested for their emergence, stem number, tuber size and yield.

Relationship of proposed research to overall problem for potato growers

1, 4-DMN is a reversible sprout inhibitor for seed storage. The results of this study offers alternative to the existing storage conditions. The main advantage with 1, 4-DMN application is sprout inhibition during transit and allows storing potato seed at elevated temperatures. This study directly benefits potato seed industry in the valley.

Timeline and expected short term (1 yr) and longer term (3-5 yrs) outcomes

1st year: Pilot scale study to identify cultivars that are responding to 1, 4-DMN treatment

2nd year: Expanding the study with cultivars that are responding to 1, 4-DMN treatment and also testing in commercial lots. In addition to sprout set, tubers will be planted and tested for their emergence, stem number, tuber size and yield.

Literature cited:

Buttery RG, Seifert RM, and Ling LC 1970 Characterization of some volatile potato compounds. J Agr Food Chem 18(3):538-539.
Coleman EC, Ho CT, Chang SS. 1981. Isolation and identification of volatile compounds from baked potatoes. J Agric Food Chem 29:42-48.
Meigh, DF, AAE Filmer, and R Self. 1973. Growth-inhibitory volatile aromatic compounds produced by Solanum luberosum tubers. Phytochemistry 12:987-993.
Kleinkopf GE, NA Oberg, and NL Olsen. 2003. Sprout inhibition in storage: current status, new chemistries and natural compounds. Amer J Potato Res 80:317-327

Project 2

Title: Testing different storage conditions to prevent spreading of silver scurf disease in storage

Nature, scope, objectives of proposed research

H. solani causative fungal pathogen of silver scarf infects only the periderm (skin) of the potato tuber. Tubers are infected during the growing season, and lesions become visible in 3 to 5 weeks. Lesions may be difficult to detect at harvest, particularly if the tubers are not washed. Primary infection takes place in the field when the tubers remain attached to the stolon and is usually seen on the skin (periderm) at the stem end of the tuber as a smooth, gray and silvery sheen. In severe cases primary lesions may shrivel and enhance shrinkage due to water loss. The fungus can infect all potatoes regardless of skin type.

Secondary infection may not significantly affect the skin structure but may severely impair the appearance of the potato. Major portion of the tuber surface and usually appear in storage and starts as black circular lesions on several areas of the tuber. Secondary lesions may produce spores or conidia that allow spread of the disease in storage. The maximum infection and spread of this disease to new potatoes from any of these sources takes place during handling and the initial 2 to 3 weeks (curing period) of storage. Infection is also increased when pulp temperatures remain warm with relative humidity above 90% along with the re-circulation of the internal air. Subsequently, the infection spread may be slowed but not completely eliminated as storage temperatures are cooled to 45°F or below. At these temperatures the fungus will live and develop slowly. This is why symptoms from a new infection site on a tuber do not appear until after 4 to 5 months.

The aim of this project is to apply bioactive compounds during the curing process in such a way that these compounds won't inhibit new skin formation but only reduce the infection and subsequent spread in the storage.

Methods and facilities, including any resource needs at the SLVRC

Susceptible and resistant cultivars will be treated with methyl jasmonate and hexenal etc during the process of curing after harvest at different concentrations and with varying exposure time. These treated potatoes will be stored at different storage temperatures and

conditions. Treated potatoes will be scored for disease incidence, weight loss and other visible symptoms after 3 months and five months relative humidity.

Relationship of proposed research to overall problem for potato growers
Packing houses requires more time for sorting and are faced with rejection of consignment infected with silver scarf. Processors have difficulty in peeling the skin off tubers when lesions on the exterior of the potato become excessive.

Timeline and expected short term (1 yr) and longer term (3-5 yrs) outcomes
1st year: Pilot scale study to identify compounds that have impact on reducing disease spread

2nd year: Expanding study by putting the treated potatoes in plastic mesh bags to place them in commercial storage and evaluate the susceptibility of potatoes.

Project 3

Title: Management approaches for increasing stem numbers in Canela Russet

Nature, scope, objectives of proposed research:
There is a general relationship between stem numbers and tuber numbers (Gillison et al. 1987). The number of eyes per seed piece influences stem numbers per plant. Young seed is characterized by the exhibition of an apical dominance over the other eyes, suppressing the sprouting of other eyes. It is mediated primarily by the hormone, indole acetic acid (IAA), an auxin (Kumar and Knowles, 1993). In the case of potato tubers, the eye and young sprout produce IAA which travels down the tuber suppressing the other eyes from sprouting. This suppression is dependent on IAA concentration as dormancy is dependent on ABA concentration. In both these phenomena, there are hormones, cytokinins and gibberellins, which can build up and counteract ABA and IAA.

Ethylene
Continues exposure of ethylene suppresses sprouting in tubers (Prange et al 1998). They are reports such treatment also reduces apical dominance and cause more uniform sprouting (Prange et al 1998, 2005, Pruski and Daniels- Lake 2003, Pruski et al 2004). Recently continuous ethylene treatment on Russet Burbank and Shepody resulted in early emergence of stem, increase stem number and increase in number of stolons (Prusky et al 2006 Daniels-Lake 2006).

1, 4-DMN
Relatively new sprout inhibitor, ethyl substituted naphthalenes are naturally occurring in potato tubers, showed sprout suppressant activity on a short-term basis approximately 30 days,(Buttery et al 1970 and Coleman et al 1981). Recent observations on usage of this product show breaking of apical dominance in potato tubers resulting in multiple shoots (Dr. Mike Lewis and others personal communication).

The objective of proposed research is to break apical dominance in Canela Russet using different and combination of treatments with ethylene and 1,4 DMN (1,4 Dimethyl naphthalene).

Methods and facilities, including any resource needs at the SLVRC
Application of chemicals and treatments will be carried out in sealed plastic barrels. The SLVRC has necessary storage rooms to carry out the proposed study. Storage rooms need to be equipped with humidifiers.

Relationship of proposed research to overall problem for potato growers:
Canela Russet is an out come of SLVRC potato breeding program. It has gained popularity among growers for its size and shape and long dormancy period. But this cultivar is daunted by some negative characteristics such as lower yield and long dormancy.

Timeline and expected short term (1 yr) and longer term (3-5 yrs) outcomes
1st year: Pilot scale study to see the effect on stem numbers, yield and tuber size in single or combination treatments

2nd year: Expanding study by optimizing concentration and putting the treated potatoes in plastic mesh bags to place them in commercial storage and evaluate the efficacy of treatments.

Literature:
Gillison TC, PD Jenkins, and JD Hayes 1987. Some factors affecting the expression of the physiological age of potato seed tubers. J Agric Sci, Camb 108:437-451.
Kumar, G.N.M. and Knowles, N.R. 1993. Involvement of auxin in the loss of apical dominance and plant growth potential accompanying aging of potato seed tubers. Can J Bot 71:541-550.
Prusky K, Prange RK Daniels-Lake BJ, Nowak J, Astatkie and Ronis DH 2006 Growth-room and field studies with seed tubers treated with ethylene and 1-methylcyclopropene (1-MCP) during storage 83:149-160.
Prange RK, W Kalt, BJ Daniels-Lake, CL Liew, RT Page, JR Walsh, P Dean and R Coffin. 1998. Using ethylene as a sprout control agent in stored 'Russet Burbank' potatoes. J Amer Soc Hort Sci 123:463-469.
Prange RK, BJ Daniels-Lake, JC Jeong and M Binns. 2005. Effects of ethylene and 1-methylcyclopropene on potato tuber sprout control and fry color. Amer J Potato Res 82:123-128.
Pruski K and B Daniels-Lake. 2003. Seed tuber storage conditions affect the tuber size in field production of two potato cultivars. The 87th Annual Meeting of PAA, Spokane,WA, USA. (abstr)
Pruski K, RK Prange and B Daniels-Lake. 2004. Seed tuber storage conditions affecting size of tuber in field production of three potato cultivars. Acta Physiol Plant 26(3): 48.

Project 4
Title: Rio Grande Russet storage considerations

Nature, scope, objectives of proposed research
Dormancy period of Rio Grande Russet is shorter than Russet Norkotah and Russet Nugget. It is around 85 days when stored at 45 °F. The objective of this project is to find optimum harvest conditions to legthen dormancy without any storage disorders.

Optimum storage conditions will be studied by manipulating storage temperature and humidity.

Methods and facilities, including any resource needs at the SLVRC
Rio Grande Russet will be harvested at 90 100 110 and 120 days after planting to get different levels of maturity. These tubers will be tested for their storability and dormancy at different temperature and humidity conditions. Tubers will be also evaluated for storage disorders periodically during storage.
SLVRC has necessary storage rooms to carry out the proposed study. Storage rooms need to be equipped with humidifiers.

Timeline and expected short term (1 yr) and longer term (3-5 yrs) outcomes.
1st year: Different harvest dates and storage conditions will be evaluated

2nd year: Based on previous year results study will be expanded further to see how cultural practices and storage conditions will effect dormancy and sprouting.

Project 5

Title: Developing disease monitoring tool in storage
Nature, scope, objectives of proposed research.
By combining the sensitivity of GC-MS (Gas chromatography- Mass spectrometry) and PCR (polymerase chain reaction) detection technology, volatiles released from infected potatoes and DNA isolated from fungal spores will be used to monitor the conditions of potato storage. In this collaborative project, our aim is to develop a simple, sensitive and cost effective detection tool, useful for commercial operations to detect a variety of soil-borne pathogens in potato storages prior to significant decay losses. In addition, newly developed detection tools will be utilized in ongoing studies evaluating the efficacy of various management options (e.g., cover crops) to control soil-borne pathogens both in the field and in potato storages.

Objectives:
1. Develop a tool to monitor diseases in potato storages based on characteristic volatiles.
2. Use PCR to amplify trapped spores on polycarbonate filters with highly specific primers.
3. Expand the technique for quantitative assessment for disease risk and predicting storability.

Methods and facilities, including any resource needs at the SLVRC
Initially, specific volatile signature will be collected from potato tubers infected with specific fungal and bacterial strains using GC/MS under laboratory conditions. This will be expanded to large potato storage rooms. VOCs will be trapped by using Super Q resin placed at ventilation systems or by passing air through traps by connecting to a vacuum pump in potato storage rooms. These traps can be collected and desorbed by organic solvent and injected into GC/MS to analyze for disease specific volatile fingerprints. Fungal spores that circulate in the ventilation system in potato storage can be trapped by using 0.2-μm pore polycarbonate track etch membranes (Poretics Corp, Livermore, CA). The filter holder will be directly connected to a battery-operated vacuum pump (Escort Sampling; Hazco Services Inc; Dayton, OH) and DNA of trapped airborne fungal spores

will be isolated from the filters. A combination of quantitative PCR and length heterogeneity analysis using conserved rRNA primers will be used to identify and quantify the various spores collected by the filters.
Fungal spore entrapment on a filter and VOCs captured on Super Q resin will be combined to increase the sensitivity of the detection technique to allow monitoring of diseases at very early stages of development in the storage.

Timeline and expected short term (1 yr) and longer term (3-5 yrs) outcomes.
1st year: Methods development

2nd year: Detection and identification of diseases laboratory scale model

3rd year: Expanding the technique to commercial storages

Project 6
Title: Analysis of potato skin mutant susceptible to powdery scab disease

Nature, scope, objectives of proposed research
Identifying the biological basis of resistance to powdery scab disease associated with russets. Our long term goals include transferring the resistance to susceptible varieties through conventional breeding programs.

Powdery scab symptoms cause significant economic losses in both fresh and seed markets. Depending on the severity of symptoms, tubers could become non-marketable or grade may be lowered in fresh, processing and seed markets. Seed lots infected with powdery scab may or may not pass inspection depending on the regulations of the certifying agency and the degree of infection. Infected tubers are also more susceptible to fusarium dry rot, bacterial soft rot and other pathogens during storage.

A better understanding of russetting mechanisms will help us to develop new cultural tools for better skin set in new varieties to enhance the native capacity of tubers for skin set. Skin setting is an important biological process in tubers that protects against biotic and abiotic stresses, and has a great impact on the potato quality.

The two important questions that can help us in understanding the powdery scab disease resistance mechanism in potato are:
A. How russet varieties have the ability to resist powdery scab lesion development compared to smooth skin varieties?
B. What role do the different types of tuber skin play in powdery scab resistance?

Recently, we have identified a smooth skin mutant of Russet Nugget (R. Nugget) which is devoid of the russetting phenotype and shows susceptibility to powdery scab lesion development compared to russet cultivars. This skin mutation offers opportunity to study the genetics of a specific russetting phenotype. Our proposal to analyze mutant using potato microarray was accepted by TIGR (The Institute of Genomic Research) Solanaceae Gene Expression Profiling Service. We submitted mutant and russet wild-type tissue samples for potato microarray analysis. Microarray analysis will lead to the identification of a list of candidate genes that are differentially expressed.

Relationship of proposed research to overall problem for potato growers
Our approach will generate markers that can identify genes or gene families that can be transferred from russets to smooth skin varieties through the traditional breeding programs.

Timeline and expected short term (1 yr) and longer term (3-5 yrs) outcomes
1st year: Microarray data analysis and confirming candidate gene expression

2 and 3rd year: Understanding the mechanism of russeting and developing markers and screening germplasm for resistance in specialty and smooth skin varieties.

Potential for leveraging results to obtain additional outside funding
The CPAC funds can be used to leverage for larger funding from external sources. This consistent base level funding helps to generate important initial data to apply for outside funding agencies such as USDA CSREES and NSF and specialty grants.

Detailed annual budget (personnel, materials and supplies, travel, equipment, Services) and a budget justification. Indirect costs are not applicable

Previous funding (2006): $10,000
During 2006, I initiated research projects on powdery scab and russet skin set and pressure bruise. Four different project proposals were submitted for National Potato Council funding (CSREES).

Requested funding for 2007:	**$38,500.00**
Research Associate (50%)	18,000.00
Labor	5,000.00
Equipment	5,000.00
Chemicals	5,000.00
Laboratory supplies	5,000.00
Travel	500.00